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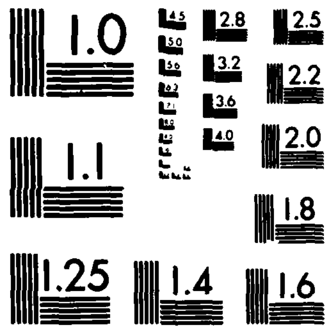

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FOREIGN TECHNOLOGY DIVISION

THE BIMOTOR TURBOPROP MULTI-PURPOSE
AIRCRAFT, THE YUN-11T (Y-11)

by

Xiong Wenjie

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THE BIMOTOR TURBOPROP MULTI-PURPOSE

AIRCRAFT, THE YUN-11T (Y-11)

by Xiong Wenjie

Since designs for the Yun-11 (Y-11) aircraft were finalized in 1977 and the aircraft began to be produced in small numbers and tried out, it has accumulated a great deal of experience in the areas of agriculture and forestry including the spraying of insecticides, spreading fertilizer and seeding, destroying insects in forests, preventing forest fires, destroying locust in grasslands and geological surveying as well as in the area of surveying rare animal resources. This aircraft's performance is especially excellent in holding low altitude steadiness. Further, it has a wide field of vision, its safeguard conditions are simple, it can takeoff and land within a short distance on a simply constructed rustic runway, and is well received for operations. Practical use over the last several years has proven that the Y-11 is a small multi-purpose aircraft with outstanding performance. Recently, plans have been made to add heating equipment and fish eye type observation windows to the Y-11 aircraft so as to adapt to the needs of northern winter operations and prospecting for resources.

Following the development of the national economy, new requirements for small multi-purpose aircraft have been proposed continually. In the area of geological surveying it is hoped that this aircraft can realize many physical methods as well as all-purpose aviation stations for surveying; aside from adapting to the low-lying areas in China's southeast, it is also necessary to be able to satisfy aviation surveying for the high plateau areas in China's southwest and northwest. In the area of short distance transport, service departments hope that while maintaining the excellent performance of the Y-11 they can also enlarge the commercial loads and the navigation range. The bimotor turboprop aircraft Yun-11T meets these new requirements given that great advancements and improvements were made on the foundations of the Y-11. The two six cylinder piston engines were replaced by two PT6A-10 turboprop engines; the total weight of the aircraft was increased from 3,250 kilograms to 5,000 kilograms; the maximum commercial load was increased to 1,700 kilograms; it uses a new airfoil with high lift-drag ratio; it uses an integral fuel tank; and it has added Doppler radar and other high precision navigation equipment. Aside from these, corresponding improvements were also made in other areas of the aircraft.

In recent years, because of the drastic rise in fuel costs due to the energy crisis, in the area of short distance transport, there has been a tendency abroad to gradually replace jet passenger aircraft with small turboprop passenger aircraft. This

has caused a rapid development in so-called branch aircraft which are also called commuters. When comparing this type of aircraft with large passenger aircraft, it is much more economical in the 400-600 kilometer range.

Aside from satisfying the requirements of geological surveying and other purposes, the Yun-11T aircraft can also meet the requirements of modern branch civil aircraft. The cabin is spacious, takeoff and landing distance is short, it can seat 17 passengers, and it can fully satisfy the American navigation regulations FAR-23 required for passenger aircraft. Tests have already been carried out on the dusting and spraying (including normal and ultralow capacities) techniques for the Y-11 aircraft and both techniques can be applied on the Y-11 aircraft to prevent insect pests in agriculture and forestry. Because the volume of the cargo cabin of the Y-11T has been enlarged it is very suitable for spraying grass and tree seeds, and for use in transforming grasslands or in afforesting the loess plateaus in northwest China.

The major uses of the Y-11T aircraft are short distance passenger transport, geological surveying and observing resources, forest operations, air drops and parachute jumps. Its main technical data is:

Length	14.86 meters
Height	5.275 meters
Wing span	17.24 meters

Wing area	34.27 meters^2
Passenger cabin (height x width x length)	1.7 x 1.6 x 4.9 meters^3
Cargo cabin door (width x height)	1.45 x 1.38 meters^2
Total weight of aircraft	5,000 kilograms
Weight of empty aircraft	2,800 kilograms
Maximum fuel load	1,200 kilograms
Maximum commercial load	1,700 kilograms
Maximum cruising speed	282 kilometers/hour
Climbing rate (H=0)	6.3 meters/second
Takeoff runway distance	220 meters
Landing runway distance	210 meters
Maximum range (45 minutes of residual fuel)	1,280 kilometers

The Yun-11T aircraft uses total layout high mounted wings, single finned tail and forward three point fixed landing gear. It is equipped with two PT6A-10 turboprop engines, the limited power of a single engine is 475 horsepower, the diameter of its three blade propeller is 2.36 meters and it has clockwise and counter-clockwise propeller units. The rectangular wings have a double spar type diagonal stay rod structure, high lift-drag ratio GA-0417 airfoils and relative thickness is 17%. To improve low speed and takeoff and landing performance, the leading edge of the wing was fitted with automatic slotted wings, the inner side of the back section has setback Fowler flaps and the outer

side has ailerons. The wing case has an integral fuel tank structure and its maximum capacity is 1,600 liters. The four sides of the fuselage are slightly curved rectangular sections and when compared to comparable aircraft, it has a more spacious cabin. The cabin height is 1.7 meters, maximum width is 1.6 meters, length is 4.9 meters, volume is 13 $meters^3$, the baggage compartments in the front and rear of the aircraft have volumes of 0.77 $meters^3$ and 1.89 $meters^3$ and their loading weights are 80 and 220 kilograms. Both sides of the aircraft have four 0.61 meter wide windows. The left rear side of the cabin has a large cabin door 1.45 meters wide and 1.38 meters high which is convenient for loading and unloading cargo or for parachuting. Opposite the cargo cabin there is a 0.68 meter x 0.66 meter emergency window and when the aircraft is used for parachuting operations this window can be enlarged wherein 14 parachutists can simultaneously jump the left and right sides.

When the Yun-11T aircraft is used for passenger transport, 17 seats can be arranged. When transporting cargo, there are 11 mooring rings on the floor which are used to fix down the cargo. The floor's load capability is 750 $kilograms/meter^2$.

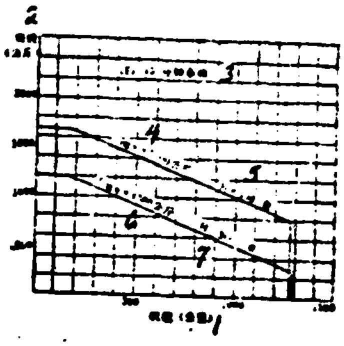

Fig. 1 Commercial Carrying Range of Yun-11T

Key: 1. Range (kilometers)
2. Commercial load (kilograms)
3. Note: 45 minutes of residual fuel
4. $G_{takeoff}$ = 5,000 kilograms
5. H=300 meters
6. $G_{takeoff}$ = 4,500 meters
7. H=3,000 meters

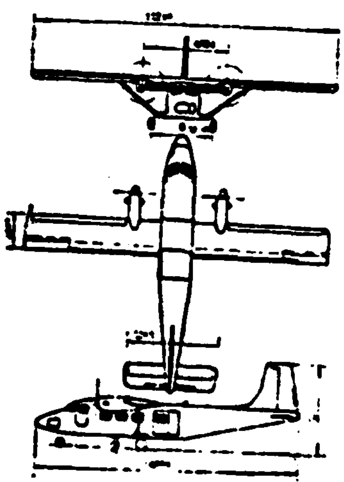

Fig. 2 Diagram of Three Sides of the Yun-11T

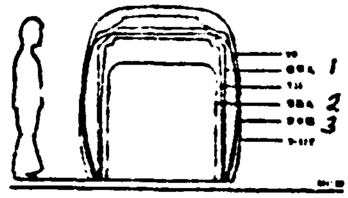

Fig. 3 Comparison of Several Types of Aircraft Cabin Transverse Sections

Key: 1. Shepherd
2. Islander
3. Double otter

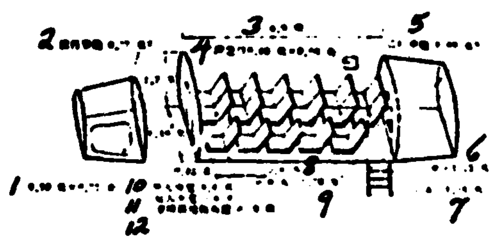

Fig. 4 Arrangement Diagram of Baggage Compartments and Passenger Cabin of the Yun-11T Aircraft

Key: 1. 0.56 meters x 0.75 meters
2. Front baggage compartment 0.77 meters^3
3. 4.9 meters
4. Emergency opening 0.68 meters x 0.66 meters
5. Rear baggage compartment 1.89 meters^3
6. 0.55 meters x 1.25 meters
7. 0.65 meters x 1.38 meters
8. 0.8 meters
9. 0.8 meters x 1.38 meters
10. Single seat width 0.4 meters
11. Double seat width 0.8 meters
12. Height between seat and floor 0.38 meters

The great majority of Yun-11T aircraft use metallic gluing. When compared with riveting or point welding, the advantages of pure metallic gluing are:

1. The structure's fatigue strength is higher because gluing avoids the stress concentration in the areas of riveting holes or welding points so that the stress distribution on the joining surface is uniform. Also, the fatigue life of the glued structure is many times greater than that of the riveted structure.

2. The glued structure can increase the critical stress of components when under stress. Tests have proven that the instability stress of glued structures is generally about 30% higher than that of riveted structures.

Structurally, the majority of Yun-11T aircraft use pure gluing. The cementing agent used is "Self reliance number 2" glue which has been practically tested for many years. The glued surface area occupies over 70% of the wing, and the integral fuel tank sections in the leading and trailing spars of the wings, the spar webs and upper and lower edge plates are also glued. Approximately, 40% of the long extension and envelope on the fuselage use gluing and this will be further extended in future production.

At the beginning of the 1970's, production plants used pure glue for the non-major stress structural components in military aircraft. After several years of use, shearing

destruction tests were done on the returned samples and results showed that after ten years of natural aging and usage there was basically no change in strength performance. The integral tanks on the left and right wings formed in the wing tank section between the number 6 and number 17 ribs of the leading and trailing spars have a capacity of 1,600 liters. The two end ribs, number 6 and 17, are composed from thick hard aluminum plates made by numerically controlled milling machine processing. The rear sections of the plates on the fuel tanks have removable opening covers to make maintenance and inspection convenient. The milled slot and poured glue method are used on the molding material's protruding edge for the sealing of the upper and lower plates within the leading and trailing spars and end rib. The end of the wing's diagonal stay in the area of the number 10 rib, made from integral plate milling which relies on a forged joint which passes through the lower plate and wing, and the lower number 4 extension. This structural form transfers the wing's flight load to the subwing by means of the diagonal stay. When in operation, the glue layer in the area of the stay joint endures the shearing stress as well as the pressure stress to ensure the sealing of the glued seam.

The major parts of the Yun-11T aircraft were all design tested before the prototype was trial manufactured. The test components are manufactured according to the total measurement proportions, and performance and strength tests were carried out. The most important are:

1. Integral Fuel Tank. Aside from carrying out kerosene seal tests under inflated pressure conditions, several types of 100% design load static strength tests were also carried out under the most serious stress conditions. After the maximum load tests, the seal for each glue joining seam of the test parts maintained well.

2. Flight test were carried out before one year after the GA-0417 new airfoil is in the Yun-11 aircraft and now more complete performance trial flights are being done. Preliminary results show that flight quality is excellent. When other conditions of the aircraft are invariant, the new airfoil can increase the maximum speed of the aircraft 3% and increase the climbing rate more than 10%.

3. The retracting system of the setback wings is completed by the power driven mechanism shifting on the slide-rail by means of the torsion bar, cable, pulley and control flaps. This system also carries out simulated tests on whole measurement surfaces as well as long distance flight tests on the Yun-11 aircraft. Preparations are being made to use chains instead of cables on the Yun-11T. Total system ground simulated tests were carried out on the prototype a day before the trial flight so as to ensure operation reliability.

4. The structural stress form of the wing and diagonal stays are basically the same as the Yun-11. The Yun-Il already has 2,200 hours of flying time, the ground fatique life tests of the wings with diagonal stays is already close to 20,000

hours and a great deal of valuable data on the structural fatigue stress features has been collected. After careful analysis, all of these experiences were used for the structural design of the Yun-11T. Structural fatigue tests are being continued on the Yun-11 and in the future fatigue life tests on the airframe of the Yun-11 will be carried out based on the new load spectrum.

The first three developed Yun-11T aircraft have now been put into production. The first aircraft will be used for complete aircraft static strength tests and the second and third will be used for flight tests. It is predicted that strength tests and total assembly will be completed in the spring of this year and trial flights will begin before May.

The Department of Geology has ordered two Yun-11T. These two aircraft will be equipped with aeroelectronic, aeromagnetic and aviation radiation survey equipment as well as navigation equipment to ensure precision measuring.

Design plans for the passenger and parachuting models of the Yun-11T will begin in 1982 and it is hoped that flight demonstrations will be conducted throughout China at the beginning of 1983.

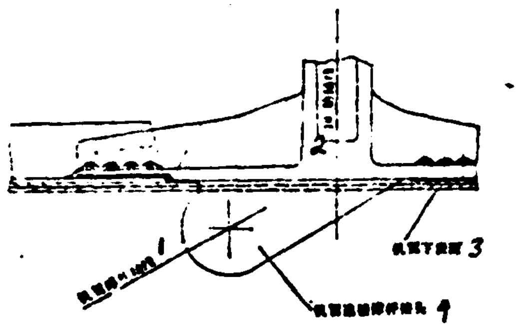

Fig. 5 The Wing's Integral Fuel Tank

Key: 1. Wing's stay axis
2. Axis of number 10 rib
3. Lower surface of wing
4. Wing joined to stay joint

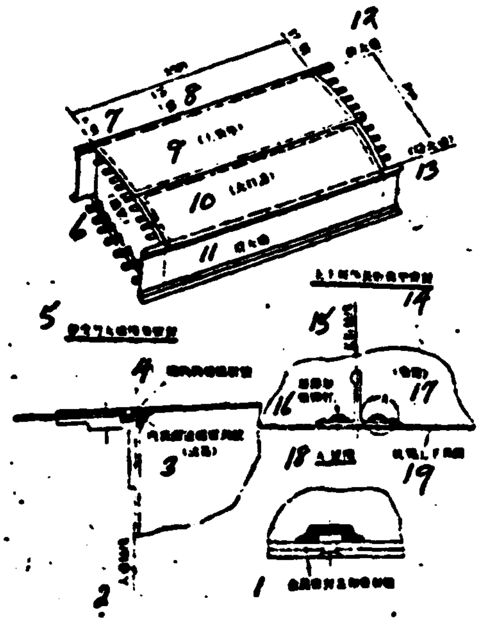

Fig. 6 Seal Form of Joint in Wing's Diagonal Stay Area

Key: 1. Metallic seal cover and seal glue
2. Spar axis
3. Inner surface edge seam seal glue (fuel tank)
4. Slot injected glue in seam
5. Envelope and spar edge plate seal
6. (End rib)
7. Number 6 rib
8. Number 10 rib
9. (Upper plate)
10. (Large opening cover)
11. Trailing spar
12. Leading spar
13. (Trailing spar)
14. Typical seal of upper and lower plate long extensions
15. Long extension axis
16. Locally strengthened rivits
17. (Fuel tank)
18. Detailed drawing A
19. Upper and lower surfaces of the wing

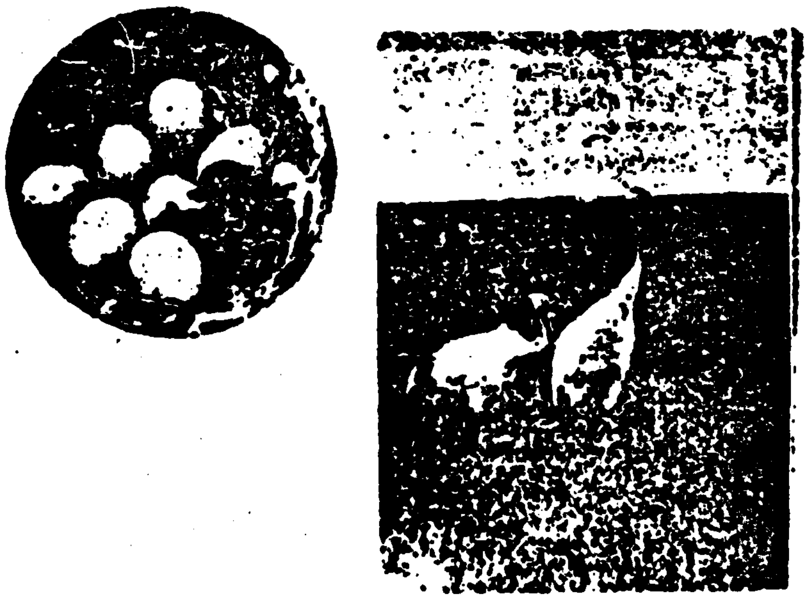

Fig. 7 These are photograhs of red-crown cranes (right) and a nest of crane eggs and newly born cranes (left) taken while carrying out rare animal observations with the Yun-11T aircraft.

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